

# Human Animal Conflict in Agro-Pastoral Context: Issues & Policies



**Pawan Kumar Agrawal  
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**Indian Council of Agricultural Research  
New Delhi -110 001**

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## Foreword

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Agriculture biodiversity provides for both food security and the planet's sustainability. Terrestrial and aquatic, plant as well as animals, gathering as well as cultivation, have been providing for sustenance of human and livestock populations over centuries. India has had a record of facing various challenges and produce over 250 mt. of foodgrains, along with other components of agriculture such as horticulture, livestock development, fisheries and aquaculture.



In the foresight analysis, it is becoming clear that food production has to be continuously stepped up, despite cultivable land going away to other economic activities and emerging challenges such as climate change, biodiversity loss, degradation of natural resources and so on. Along with these are the abiotic stresses such as temperature, rainfall patterns, salinity, etc. and biotic stresses by the pathogens, parasites, insects and so on. Another emerging concern in Indian agriculture is the impact being caused by the vertebrate pests and wildlife.

While there have been illustrious studies on the above areas in the country, with increasing habitat destruction, human-wildlife conflicts have become an issue in agricultural production and management. A consortium approach is necessary for effectively addressing the impact of wildlife on human activities including agriculture as also *vice versa*, plan approaches for co-existence and make them as societal functions. The ICAR-NIAS workshop on 'Human-Wildlife Conflicts' held at Bengaluru during 11-12 December 2015, was a forerunner in this regard and the publication is an output of the event, a way forward.

I would like to thank Dr. Baldev Raj, Director, NIAS Bengaluru and compliment all the colleagues of NIAS and ICAR for this effort. I hope this would pave way for more work in science and policy in the area in the years to come.



(S. Ayyappan)

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# **Human-Wildlife ‘conflict to coexistence’ in Agro-pastoral landscapes**

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## **Introduction**

Human-Wildlife Conflict (HWC) is defined as any interaction between wildlife and humans which causes harm, whether it is to the humans or wild animals or property (including the destruction of crops). Conflict arises from a range of direct and indirect negative interactions between humans and wildlife. These can culminate in potential harm to all involved, and lead to negative human attitudes, with a decrease in human appreciation of wildlife and potentially severe detrimental effects for conservation (De Boer & Baquete, 1998; Nyhus *et al.*, 2000). Conflict generally arises from economic losses to agriculture, including loss of cattle through predation and destruction of crops. In arid areas it often occurs over access to water and competition for resources. A wide range of species is responsible for conflict, with the principal culprits being primates, rodents, ungulates (including antelope, wild boar, elephant, tiger, lion and leopards). Livestock also perpetrate significant damage, however, there are often locally accepted measures of restitution (Naughton-Treves, 1998). Conflict situations can arise anywhere, and are frequently concentrated at the fringes of reserves where wildlife enjoys protection and land is often fertile, leading to a wealth of agriculture.

There are other socioeconomic costs associated with human-wildlife conflict which can outweigh the direct costs of agricultural damage and be a major component of the conflict as perceived by local people (WWF, 1997). The extreme example of this is human death, but other examples include restrictions on movement, competition for water sources, the need to guard property (which may lead to loss of sleep), poor employment opportunities and increased psychological stress.

## Dimensions of HWC

In recent years HWC in agricultural landscapes is an increasing factor of concern for managers. India is the seventh largest country in the world and second largest nation of Asia having 10 different biogeographic zones, encompassing varied landscapes with rich natural resources. India also has the rich diversity with approximately 45,000 species of plants, 86,874 species of animals, 390 species of mammals, 1300 species of birds, 456 species of reptiles, 311 species of amphibians and 2546 species of fishes. All the bio-geographic zones are facing the issue of HWC from variety of species, in varying degrees. The major species involved in the HWC are Snow leopard, Himalayan bear, monkeys, wild ass, *nilgai*, black buck, wild boar, elephant, leopard, sloth bear, gaur, tiger, porcupine and crocodile. In Trans Himalayas and Himalayan zones the HWC is mainly due to snow leopard, Himalayan bear and monkeys. The wild ass and *nilgai* problems are severe in regions like Thar and Kutch of desert zone. The number of problematic species involved in HWC is comparatively similar in semi-arid, Western Ghats, Deccan peninsula and Gangetic plains. In these zones the predominant species like wild boar, *nilgai*, monkeys, elephants and other antelopes cause significant HWC in relation to agricultural landscape, while other species like tiger and leopard cause predation on livestock and human death.

The ways in which HWC occurs are as follows

- i) **Killing of humans:** Any species that attack the human being for defence purpose or for food that leads to death; species like tiger, leopard, lion, sloth bear, elephant are involved.
- ii) **Killing of livestock:** Any species that preys on the livestock; leopard, lion, tiger and wild dog.
- iii) **Accidental injury:** Any species that accidentally attacks humans or livestock for self protection, gaur, *nilgai*, elephant, leopard, tiger, wild boar and crocodile.
- iv) **Damage to agricultural crops:** Due to non-availability of preferred dietary items in the original habitat, the animals are compelled to depend on agricultural crops for food and make enormous damage to the crops; wild boar, *nilgai*, elephant, rhesus macaque and black buck.
- v) **Property damage:** Species involved in damaging the households or any other structures: elephant, rhesus macaque and bonnet macaque.

The basic reasons for Human-Wildlife Conflict is the loss of species-specific habitats, habitat degradation and fragmentation, intensive agricultural practices, insufficient prey base and food material, increase in human and

livestock population, competitive exclusion of wild herbivores, land use transformation, developmental activities, growing interest in ecotourism and increasing access to nature reserves. The basic requirements of space, shelter and food overlap between humans and wildlife, creating conflicts.

Management of problematic species mainly depends on their status as per the Indian Wildlife Protection Act 1972 (IWPA) and International Union for Conservation Nature (IUCN). The species like tiger, leopard, lion, sloth bear, snow leopard, elephant, black buck, gaur and crocodile are kept under Schedule–I, species like rhesus macaque, bonnet macaque and wild dog are listed under Schedule–II and other problematic species like wild boar, *nilgai* are covered under schedule–III of IWPA. Whereas, as per IUCN, tiger, snow leopard, elephant and wild dog are listed as endangered; lion, sloth bear, gaur and crocodile are listed as vulnerable; leopard and black buck listed as near threatened and others like wild boar, *nilgai*, rhesus macaque, bonnet macaque are listed as least concerned species. The status of these species as per IWPA and IUCN is the hurdle while dealing with the species in agro-pastoral ecosystems. Apart from these, the major constraints in vertebrate pest management are: lack of sustained efforts at local level, strong religious sentiments against killing, high cost of eliminating animals, lack of coordination with district authorities and lengthy procedure for declaration as vermin.

### **Agricultural damages due to Wildlife**

All the animals and birds listed in India are not problematic in causing HWC. Among the 103 species of rodents listed, only 13 species were found to be involved in agricultural damage at different growth stages of the crop. In case of birds of the 1364 species, 63 species were identified as depredatory in nature and causing damage to various agriculture and horticultural crops mostly during vulnerable stages of the crops. Among the six antelopes reported in India, three species like *nilgai*, black buck and four horned antelope were reported as crop riders. Similarly, of the nine deer species, only spotted deer has been reported involving crop damage in the fringes of forest blocks. Out of 13 species of primates listed, five species are involved in crop damage across different agro-ecological regions. The other species like elephant predominantly causes crop damage, property loss and injuries to humans mostly in forest fringes and also during migration across the corridors. The wild boar is the most problematic species causing significant crop damage across different agro-climatic zones of the country.

Studies conducted by the All India Network Project on Vertebrate Pest Management over a decade showed that the extent of damage caused by



different species of rodents was to the tune of 15%, followed by birds 9%. Recent studies revealed that the wild boar damage to different crops varies from 15-40%, *nilgai* to the extent of 10-30%, elephants, 20-50%, rhesus macaque, 10-30%, black buck, 5-15% and gaur, 5-10%. The intensity of damage depends on population density, cropping pattern, extent of crop area, season and stage of the crop.

Carnivores often cause serious economic and social losses by preying on livestock, causing damage to property and general community insecurity, and in exceptional cases, human injury or death (Madhusudan and Mishra, 2003; Mishra *et al.*, 2003; Distefano, 2005; Ogra and Badola, 2008; Ogra 2008; Lee, 2011). The economic loss due to snow leopards (*Panthera uncia*) and wolves in Spiti region of the Indian Trans-Himalaya has been estimated at Rs. 8000 per family annually, amounting to about half the per capita income of the state (Mishra 1997). Also a similar study by Maheshwari *et al.* (2010) showed over 2% livestock loss every year due to snow leopard, Tibetan wolf and Himalayan brown bear (*Ursus arctos isabellinus*) in Kargil, Ladakh. The impact is exacerbated if the loss is of human life. Similarly, during 2007-2011 a total of 888 human deaths were reported across several regions due to wild animals and compensation was reported to the tune of Rs. 5.72 crores. In case of human injuries, a total of 7,381 cases were reported with a compensation of Rs. 3.4 crores. Several crop damage cases were also reported by wild animals and compensation paid to the extent of Rs. 10 crores. The antagonism arising from conflict with carnivores pushes people towards retributive killings, that have a substantial impact on the carnivore population undermining the conservation efforts (Woodroffe *et al.* 2005, Dickman, 2008; Hazzah *et al.*, 2009). Therefore, reducing antagonism caused mortality is an important strategy for conservation of carnivores (Lee, 2011).

### **Population estimates and Management**

Estimating population density of animal species, more specifically the mammalian species that attract conservation interest (Krishnan, 1972; Ramachandran *et al.*, 1986), is an important tool for their conservation and population management (Karanth and Sunquist, 1992; Varman and Sukumar, 1995; Sutherland, 1997; Varman, 1988). However estimating animal numbers in tropical forest habitat is difficult, because of poor visibility and relatively low density of some species resulting in inadequate sample sizes for obtaining statistically precise results (Koster and Hart, 1980; Varman and Sukumar, 1995). Also except in a few locations, no systematic or scientific approaches have been followed to estimate population densities. Population numbers that are available for species such as the Asian elephant or prey species of large

carnivores originate only from census programs. Although these census operations are systematic or assumed to be successful, their results are neither validated nor compared with any other long-term population studies on the species (Verma, 2007). The available population status of some of the problematic higher vertebrate species, based on secondary information revealed that the tiger population reported approximately 2,226 individuals, leopards ranging between 12,000-14,000, *nilgai* in outside protected areas having over five lakh individuals, elephants, over 25,000 individuals, gaur, more than 20,000 and sloth bear around 10,000 individuals.

In several countries like America, England, Poland, Russia and Japan control of problematic animals in agricultural landscape is done through hunting, caging, shooting, electrocution and translocation. In certain situations, poison baits on a large scale are widely used, as in Pakistan, for managing the wild boars. In Bhutan on the other hand, trained groups of farmers are engaged in hunting the wild boars. Italy is a country where wild boar menace is kept under check by using sodium monofluro acetate or warfarin. Despite the above methods being effective in problematic vertebrate management, none of them is applicable for Indian conditions as most of the problematic animals are listed in Schedule I to III of Wildlife Protection Act 1972. Any method resulting into either intentional or unintentional death of the animal is punishable. However, sections 11 & 12 of chapter III dealing with the Hunting of Wild animals, permit the hunting in certain cases. The various State governments like Gujarat, Punjab, Haryana, Himachal Pradesh, Uttarkhand, Uttar Pradesh, Karnataka, Telangana, Tamil Nadu, Andhra Pradesh and Maharashtra are providing compensation for the people affected by wildlife. In such a situation development of vertebrate management practices in India need to be strategic, logical, economical and above all, must be legally sound.

There are various management practices suggested by different organizations to control the wild animal entry into the agricultural fields. Though there are several methods like traditional techniques, acoustic deterrents, physical barriers, vegetative barriers, various types of fencings, chemical deterrents, capture and relocation of the problematic animals and fertility control are available, no data on large scale evaluation and efficacy is available.

Keeping in view the severity of the problem in agriculture associated with wild animal species, ICAR launched an All India Network Project on Vertebrate Pest Management during the XII Plan period. Besides studies on birds and rodents, management of higher vertebrates is an important component of the

Network. The Project envisages to undertake detailed studies on ecology and management of three most important wild animal species, viz., *Nilgai* (*Boselaphus tragocamelus*); wild boar (*Sus scrofa*) and monkey (*Macaca* sp) to minimize the crop losses *vis a vis* farmer-animal conflict in agricultural landscape. In this regard AINP on VPM (ICAR) developed way forward to deal with these animals taking care of loss of agricultural production, legal instruments and man-animal conflicts.

## **General issues related to target animals for R&D activities**

### **1. Risk Assessment**

Assessment of population of target animals may be planned along with mapping the pestilence in different agro-ecological zones of the country. The assessment includes behaviour, ecology and niche analysis of target pests.

### **2. Technology options**

**Short term:** Traditional methods, viz., trenching, fencing (bio as well as mechanical); trap crops and non-chemical methods may be advocated. Formation of National Expert Group comprising of experts from ICAR, AINP VPM, IVRI, MoEF, WII and State Forest Departments can be considered for advisory role.

**Long term:** Sterilization, bioacoustics, reproduction control methods, policy planning, repellents, participatory management plans; Integration of control methods; Creation of database on population *vis-a-vis* damage patterns in agricultural landscape; Training for awareness creation.

### **3. Policy imperatives**

Advise the Ministry of Environment and Forests to rationalize Wildlife Protection Act in need-based manner and under exigency to facilitate farmers to take timely management measures; Translocation of monkey troops following IUCN guidelines from problematic areas to wild forest area to monkey homes managed by Compassionate Unlimited People for Animals (CUPA) and People for Animals (PFA); With respect to *nilgai*, farmers are often reluctant to kill due to religious taboo. Hence, emphasis on changing the proposed common name as *vanaroz* may be considered.

### **4. Strategies**

- Large scale demonstration and popularization of different methods through extension.
- People be discouraged to offer food/feed monkeys around temples and tourist places, wherever they are problematic.

- Preparation and circulation of documents on (i) Wildlife Protection Act schedules concerning the target animals for awareness creation (ii) Technologies available to be demonstrated at pilot scale through ICAR/SAU System (KVK).
- Meetings to be arranged by ICAR for focused discussion with senior officials of MoEF on Wild life Protection Act and other issues related to MoEF-higher vertebrate pests. The agenda may also cover issues in context of human-wildlife conflict.
- Organization of high level meetings for showcasing species-based proven technologies.
- Need based basic research topics to be allocated to students by SAUs/ICAR Institutes for Ph.D. programmes.

### **Technologies ready for pilot testing through KVKs**

- **Wild boar** : Use of barrier crops, physical barriers, non chemicals
- **Nilgai** : Use of male excreta, castor barrier
- **Monkeys** : De-branching of overlapping tree canopy, non preferential crops.

In order to increase the production/ productivity for a growing population, large areas are being brought under cultivation by replacing natural ecosystems with human managed systems, thus resulting in fragmentation of habitats for wild animals, that forces them to inhabit croplands causing severe damage to standing crops. Reduced predatory pressure and regular availability of nutrient rich food (crops) round the year are likely to provide greater resilience and adoptability of wild animals, which allows them to live successfully close to agricultural landscape and human habitation. The man-animal conflict occurs when wild life requirements overlap with those of human populations, creating costs to both to residents and wild life. To mitigate the HWC, the following challenges and way forward need to be addressed for sustainable coexistence:

- In agro-pastural landscapes, Human Animal Conflict needs to be converted into Human Animal Co-Existence.
- Maintaining the delicate balance between Wild life Protection Acts and Crop Protection modules for Vertebrate Pest Management (VPM).
- Development of location specific VPM practices duly attaching practicable time lines for withdrawal mechanism.

- Creating safe zones for Wild life as an integral part of agro-pastoral landscapes.
- Evolving synchronization between wildlife biologists and plant protection specialists for a win-win strategy.
- Creation of buffer zones in the cropped areas, duly working out economic modalities on the basis of agro-ecological zones of India.
- Development of precise Data Base on crop damage by animals to implement VPM on priority.
- Multi-locational evaluation of developed VPM practices for enhancing their applicability across India
- Development of HRD in VPM through extensive training to agricultural scientists in wild life Protection laws
- Organization of awareness programmes in VPM to inculcate a sense of social responsibility in adopting VPM practices.

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## Vertebrate pests - Issues and management strategies with relevance to Wild Boar (*Sus scrofa*)

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Across the world, as human populations have expanded, wildlife species have been restricted to small patches and land has been transformed to meet human needs like settlement, cultivation, construction of roads, railways, and other infrastructure projects. Indiscriminate destructions and fragmentation of natural habitats, blocks migration routes, facilitates encroachment, and encourages poaching, all these factors cumulatively force the wildlife to restrict to small patches, thus resulting in severe conflicts between humans and wildlife. These changes often increase the potential for conflicts between wildlife and people that result in damage to resources and threaten human health and safety. Human-wildlife conflict has been a well known problem in vicinities of protected and non-protected areas. Incidences of human casualties, livestock depredation and crop damage caused by wild animals *e.g.* elephant, tiger, lion, sloth bear, leopard, nilgai, deer and wild boar have been widely reported from various parts of India (Bargali *et al.*, 2005, Chauhan, 2005a,b, Bargali, 2003, Manakanda and Rahmani, 1998, Mishra, 1997, Chandra. 1997, Rajpurohit, 1996, Saberwal *et al.*, 1994, Indrukar *et al.*, 1994, Sinha and jha, 1994, Chauhan and Singh 1990 and Schultz 1986). Many species (including elephants, rhinoceros, and tigers) are killed for international trade of their body parts. Although poaching is not a direct source of conflict, injured elephants and other animals (*e.g.*, tigers) often retaliate by killing humans and damaging their property. The other important phenomenon due to crop raiding by different species of animals which led these activities increases conflict between farmers and wildlife throughout the world. Crop raiding by animals, in particular mammals like elephants (*Elephas maximus*), gaur (*Bos gaurus*), blackbuck (*Antilope cervicapra*), chinkara (*Gazella bennetti*), wild boar (*Sus scrofa*), Hanuman langur (*Semnopithecus entellus*), and porcupine (*Hystrix indica*) has been widely reported from all over the country (Prater, 1971; Schultz, 1986; Sukumar, 1990; Bohra *et al.*, 1992; Balasubramanian *et al.*, 1993; Chhangani, 1994; Chhangani, 2000; Chhangani and Mohnot, 1997; Chhangani *et al.*, 2002; Rao *et al.*, 2015a,b).

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The wild boar is one of the most widely distributed large mammals occurring in North Africa, Europe and Asia. Worldwide, there were 16 species of wild boars and wild pigs, the species present in India is Eurasian wild boar (*Sus scrofa cristatus*). It is distributed in almost all the states of the country. Wild boars are prolific breeders and apparently breed throughout the year. The reproduction period in wild boar is seasonal and mostly correlated with availability of food and other climatic factors. The males sexually mature between the ages of 5 and 7 months and females between 4 and 6 months. The males reach the sexual maturity in 15 and 24 months but they will not mate until they have reached their full size at five years of age, and females at 18 months of age. In recent years the species is majorly indulged in crop raiding and has become a major pest in agricultural ecosystem. Wild boars are omnivorous, living on crops, roots, tubers and carrion. Wild boars in general moves in groups and their activity is more during early morning and evening hours, peculiarly active at dawn & dusk than in the actual day period. They possess a unique feature of identifying cropped areas through their smell sensory mechanism. As per IUCN, wild boar is listed under 'least concerned' category, while it is under Schedule III of Indian Wildlife Protection Act 1972.

To date there has been comparatively little systematic research carried out to investigate patterns of crop raiding activity by wildlife and its potential impact on farmers' food and household economic security. The majority of the research that does exist has focussed on the issues related to crop damage by elephants and rodents, yet other animals such as primates, and ungulates, are often cited as troublesome 'pests' in agricultural areas all over the country.

Keeping in view the severity of the problem associated with the wild animal species, to minimize the crop losses and also farmer - animal conflict in agricultural landscape, ICAR has launched an All India Network Project on Vertebrate Pest Management during XII Plan period. Besides studies on birds and rodents, management of higher vertebrates is an important component of the Network; the AINP on Vertebrate Pest Management had extensively studied the behavior and pest status of the targeted species wild boar and developed some potential strategies to



control the wild boar damage in agricultural fields. The methods are proved effective in several locations but need to evaluate in different agro-ecological regions of the country.

## **Eco-friendly cost effective management methods**

### **I. Biological barriers**

#### **i. Use of four rows of Safflower as barrier crop**

The practice of having 4-5 rows of safflower crop (high density) as border around ground nut found to be most promising in preventing the damage by wild boar. Safflower crop by being thorny in nature causes great amount of inconvenience and damage to wild boar especially under situations when it is sown in closed spacing (row to row 30 cm and plant to plant 10cm). In addition, safflower crop emits strong chemical odour effectively masking the odours emitted by ground nut crop. Due to this wild boar at the first instant fails in locating the ground nut crop, secondly even if it is locates the thorns of the safflower plant causes mechanical injury or damage, thereby they will not try to enter into the ground nut field. By using this, extent of damage by wild boar can be minimized to the level of 75 – 90% and also additional income realized through safflower crop comes as an added advantage to the farmer.

#### **ii. Four rows of castor around the crop**

This method is widely being popularized in maize and sorghum crop by planting 4-5 rows of castor with close spacing (high density with row to row 45cm and plant to plant 30cm) around the maize crop. Wild boars being capable of identifying maize only through smell can't do so owing to the strong odour emitted by the castor successfully masking the odour emitted by the maize crop. Damage in castor by wild boar is also not possible due to the non palatable nature of the plants with high amount of alcholodies and glucoscides. Through this method, a farmer is benefitted with additional income through castor. Usage of castor as border crop is practicable in both *Kharif* and *Rabi* seasons and the same crop can be used as border crop in crops like pulses and oil seeds. This method effectively controls the wild boar damage to the extent of 75-90%.

## **II. Physical barriers**

### **i. Circular razor wire as physical barrier**

The iron wire fixed with sharp razor blades at regular distance is kept 1 ft away from the cropped area as border by forming circular rings. The blades caused serious damage to the wild boar which tries to enter into the field. This not only prevents the animal to enter into the field but also scares away other animals. The entangled animal makes alarm calls which deter away the other wild boars thereby saving the entire crop without any damage. Implementation of this method reduced the wild boar entry into the cropped area to the extent of 70-85%.

### **ii. HDPE Nylon Fish net as physical barrier**

The fish nylon net (HDP, UV stabilized, 2" mesh and 1.5mm thickness) using bamboo or strong wooden poles should be erected around the crop vertically for about 3 – 4 feet height. At every 10 – 15cm nails to be fixed on the poles for better fixing of the net. Insert the nylon rope in between the mesh net and fix horizontally on the ground by using small wooden pegs. This method prevents entry of the animal into the fields and also if by chance animal enters will be entangled and makes alarm calls which deter away the other wild boars. Erecting of fish net around the field reduce the wild boar damage to the tune of 70-90%.

### **iii. GI wire fence**

A simple GI wire can also be use to create physical barrier for wild boars where three rows of GI wire fixed around the crop with the help of poles with a height of 1 feet from the ground level. This method is comparatively simple and economical method as compared to other barriers. The animals by coming in contact with GI wire feels threatened and gets scared away by confusing the GI wires with electric fences and reduce the damage caused to the extent of 55-70%.

### **iv. Barbed wire fence**

Erecting of barbed wire around the field in three rows with first row being at the height of 1 foot from the ground. This is highly effective in preventing wild boars from entering into the cropped area to the extent of 60 -74%.

#### **v. Chain link fence**

It is an easy and most effective way of fixing a barrier which is more durable in nature. Chain link meshes of 3 feet height can be fixed around the crop by maintaining a distance of 1 ft away from the crop. This method can be used in seed production crops and also in various horticultural crops. By using this permanent physical barrier the extent of damage by wild boars reduced by 65-80%.

#### **vi. Solar fence**

This is a permanent type of physical barrier arranged around the cropped area which is gaining more popularity in the present times. This method is being widely practiced to prevent the damage by wild boar in high valued remunerate crops. In this method a solar fence is fixed around the crop with 12 volts electricity being sent to the fence with the help of solar plates. The shock received by the animal during the contact will not be capable of killing the animal but certainly ward off not only the animal which comes in contact but also other following animals which will be scared due to the alarm calls of the shocked animal.

### **III. Chemical and non-chemical methods**

#### **i. Spraying of egg solution**

By exploiting the habit of the wild boar using smell of the crop as criteria for identification, an extensive level of experiments were carried out to use spray of egg solution either on the border row of the crop or on the wet soil around the crop. The results has given a clear cut indication that spray of egg solution 20 ml/ltr of water was capable of successfully making the natural odour of the crop and thereby reducing the wild boar damage up to 55-70% .

#### **ii. Use of Phorate / Thimet granules**

Phorate / Thimet granules is having strong smell of chemical which is exploited under this method to mask the original smell of the crop acting as guiding source for wild boar attack. 200 gms of Phorate / Thimet mixed with 1 kg of sand is tied in perforated polythene bags and are arranged around the crop at the distance of 3 mts maintaining a height of 60-100 cm from the ground level. Slow release of the smell of Phorate / Thimet by wind currents through polythene perforation will prevent

successfully the wild boar attack. As in earlier cases strong smell of Phorate / Thimet will also help in the masking of natural smell of the crop, there by confusing the wild boars in locating the crop and reduce the damage up to 50-65%.

### **iii. Arrangements of coconut ropes soaked in mixture of sulphur + pig oil.**

Arrangement of coconut rope in three rows around the crop by keeping 1 ft distance between the rows with the help of wooden poles can be done. Preparation of solution with sufficient quantity of sulphur is mixed with local / domestic pig oil is done and that mixture should be smeared on the arranged coconut ropes. This mixture generates the typical smell there by repelling wild boars not to enter into the cropped area. For an effective use of this method two such applications should be done with ten days interval in between, this method is effective up to 60-80%.

## **IV. Traditional methods**

### **i. Human hair as respiratory deterrent**

Wild boar with poorly developed sight and hearing mechanism has to depend on its smell sensory mechanism only for movement as well as locating of food. In this process it moves from one place to other place only by a way of sniffing on the ground there by getting guided in to the desired routes. Spreading of human hair collected from local barber shops is an affective and low cost traditional method being followed by farmers. Technically this indigenous method do have scientific logic which clearly suggest that the human hair in the movement routes wild boar gets sucked through nostrils causing severe respiratory irritation. Due to this the wild boar gets totally disturbed and loses its track by making distress calls, which will ward off other wild boars entering into the cropped area. Several farmers are extensively practicing this method in different crops and controlling the damage caused by wild boar to the extent of 70-80%.

### **ii. Fixing of used colored sarees**

This method also is a farmers' innovation, which has a behavioural background as far as wild boar is concerned. By arranging used sarees of

different colors around the crop will make wild boars to assume human presence in the area there by not preferring to enter into such areas. Even though, not feasible in all situations it has some marginal benefit in the areas of human movement. By using this, extent of damage by wild boar can be minimize to the level of 45-60%.

## **V. Bioacoustics**

The bioacoustic technology uses only sounds of predators, distress and alarm calls of target and closely related species of target animals. The calls are broadcast in a field by suing an electronic platform with sound drives. Bioacoustic tries to convey the message 'this area is dangerous' to the target animals in their own language. On hearing the sounds, the target animals start avoiding the area, thus saving the crop from being damaged. The sounds are natural and safe on humans, birds and animals.

The equipment produces fixed volume of 110 dB at source covering an area of 4-5 acres when ambient noise level is around 42 dB. At 37 dB of ambient noise, the equipment can cover up to 19 acres. The equipment should be ideally installed when the animal damage is beginning. Bioacoustics is 92% effective in dispersing wild boar from the cropped area.

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Castor (four thick rows) around the maize crop



Safflower (four thick rows) around the Ground nut crop



Circular razor fence around the crop





Chain link fence around the crop



Barbed wire fence around the crop



HDPE Nylon fish net around the crop



Spraying of egg solution around the crop bunds



Arrangements of Coconut ropes soaked in mixture of Sulphur + Pig oil



Use of Phorate / Thimet granules



Spreading of human hair as thin layer around the crop



Fixing of used coloured sarees as border around the crop



Installation of bioacoustic equipment in field



# Vertebrate Pest Management in Agriculture

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## Introduction

Crop raiding by animals, in particular mammals like elephants, gaur, blackbuck, chinkara, wild boar, monkey, Hanuman langur, Nilgai etc has been widely reported from all over the country. Incidences of human casualties, livestock depredation and crop damage caused by wild animals *e.g.* elephant, tiger, lion, sloth bear, leopard, nilgai, deer, wild boar etc. are been widely reported from various parts of India. However, damage to properties and agriculture crops by most of the higher vertebrates is not well documented and is likely limited to isolated incidents where these animals cause damage while searching for food. In case of Wild boar and Nilgai, due to suppression of their natural habitats and food resources, these animals are forced to depend on the agricultural crops. In case of Rhesus macaque, in recent days most of the populations came out from their natural habitats and become commensal (Southwick and Siddiqi 1994). These commensal monkeys have started increasing in populations, due to availability of potential food resources and less predatory pressure. As populations expand into areas near residential areas, concerns arise from the potential for people to begin feeding monkeys which conditions the monkeys to associate people with food sources. This association can often lead to attacks on people and damage to property as monkeys search for food in residential areas. Most of the Rhesus macaque populations are becoming semi commensal and frequently raiding on the agricultural crops and cause enormous damage to the agriculture and some of them are found sitting along the road sides and begging food from the vehiclars, and in some situations monkeys have started attacking on the human beings and steeling food from them.

To date there has been comparatively very little systematic research carried out to investigate patterns of crop raiding activity by wild animals, its potential impact on farmers' food and household economic security and ways and means to manage them. The majority of the research that exist at present has focused on the issues related to crop damage by rodents, however information on higher vertebrates such as primates and ungulates often cited as troublesome 'pests' in agricultural areas is scant and scattered.

## STATUS AND DISTRIBUTION

### NILGAI (*Boselaphus tragocamelus*)



**Fig. 1. Herd of Nilgai raiding the crop fields**

The nilgai is the largest Asian antelope and is one of the most commonly seen wild animals of central and northern India. The animal, a native of India, Nepal and Pakistan is widely distributed in India and in the lowland zone of Nepal, extending into border areas of Pakistan. The present distribution of nilgai ranges from the Himalayan foot hills, to southward to the southern states of Karnataka and Andhra Pradesh through central India. Their range also covers the area from the Gir forest, all along the entire eastern length of Pakistan, across the border of Rajasthan in the West to the states of Assam and West Bengal in the East.

As per IUCN Nilgai is listed under 'least concerned' category while Indian Wildlife Protection Act, 1972, grouped it under Schedule IV. The Nilgai population in India is estimated to be over one lakh. In the states of Haryana, Uttar Pradesh, Rajasthan and Gujarat the population of the animal is regarded to be common to abundant in agricultural fields. Their population is low in Nepal, rare in Pakistan and now extinct in Bangladesh. As per the IUCN the population is considered to be stable. Densities of Nilgai in India vary widely depending on habitat conditions, competition with domestic livestock, predation, and degree of protection: Some reports indicate that their population density varies from 0.23–0.34 individuals/Km<sup>2</sup> (Indravati National Park); 0.39–1.47/km<sup>2</sup> (Gir Lion Sanctuary); 0.44–7.81/Km<sup>2</sup> (Panna National Park); and 6.60–11.36 /km<sup>2</sup>

(Ranthambhore National Park). Nilgai is diurnal in habit and is very sociable creature, usually found in single-sex or mixed-sex herds of 4-20 members.

Nilgai mostly prefer scrubland and woodland with low trees and shrub densities. It avoids dense forest and has preference for plains and low hills with shrubs. They feed mostly on grasses as long as green grasses are available in large quantity but switches over to browse on fallen leaves, flowers and fruits also.

### **WILD BOAR (*Sus scrofa*)**



**Fig. 2. Herd of wild boars moving towards crop fields**

The wild boar is one of the most widely distributed large mammals occurring in North Africa, Europe and Asia. Worldwide, there were 16 species of wild boars and wild pigs, the species present in India is Eurasian wild boar (*Sus scrofa cristatus*). It is distributed in almost all the states of the country. As per IUCN, wild boar is listed under 'least concerned' category, while it is under Schedule III of Indian Wildlife Protection Act. In recent years the species is majorly indulged in crop raiding and has become a major pest in agricultural ecosystem. Wild boars are omnivorous, living on crops, roots, tubers and carrion. Wild boars in general moves in groups and their activity is more during early morning and evening hours, peculiarly active at dawn & dusk than in the actual day period. They possess a unique feature of identifying cropped areas through their smell sensory mechanism.

### Monkeys (*Macaca sp*)



**Fig. 3. Pattern of damage by monkeys in paddy**

Of the two monkey species, Rhesus macaque (*Macaca mulatta*) is the most widely distributed species throughout mainland Asia; from Afghanistan to India and Thailand to Southern China, Bangladesh, Bhutan, Nepal and Pakistan, Cambodia, Vietnam and Laos. They range from equatorial to temperate ecosystems, from evergreen primary forests to grasslands, mangrove swamps, semi-deserts and even areas of dense human habitation. Rhesus troops comprise a mixture of 20–200 males and females. Females may outnumber the males by a ratio of 4:1.

The Rhesus macaque, which is a “Least Concerned” species as per IUCN has been put in the Schedule-II of Indian Wildlife Protection Act (amended in 2002). In India, Rhesus macaque has been reported in good numbers from peninsular region (Assam, Madhya Pradesh and West Bengal), North region (Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Rajasthan & Gujarat) central region (Orissa & Bihar). Existing literature lists only the presence of bonnet macaque (*Macaca radiate*) in the Southern India.

### **Why higher vertebrates are a problem in agriculture?**

In order to increase the production/ productivity for growing population, a large area is being brought under cultivation by replacing natural ecosystems to human managed systems resulting into fragmentation of habitats for wild animals which forces them to inhabit croplands causing severe damage to standing crops. Degradation of natural habitats, reduced predatory pressure and regular availability of nutrient rich food (crops) round the year are likely to provide greater resilience and adoptability of wild animals which allows them to live successfully close to agricultural landscape and human habitation. In

fact man-animal conflict occurs when wild life requirements overlap with those of human populations, creating costs to both to residents and wild life. Except for a few sporadic reports, no comprehensive information is available with respect to status and distribution, population densities, habitat utilization food and feeding habits, social behavior and crop damage of nilgai, wild boar and monkeys in relation to agricultural landscape.

Some socio-religious reasons too play an important role in population increase of such animals. For example; Nilgai is regarded as sacred animal in India precisely because of its common name 'gai'. Likewise monkeys are considered to be Lord Hanuman. Therefore they are protected against hunting by several communities.

### **Damage to Crops**

In recent year, problems of higher vertebrates, like Nilgai (blue bull), wild boar, monkeys etc. in agriculture are on rise in many regions and many times severe crop damage is reported. Reports indicate that nilgai population is increasing because of prolonged breeding activity, high rate of multiple births and lack of predators. Damage is mainly due to foraging and trampling of crops during resting and movement. At a low population density levels, the nilgai cause damage to the tune of 20-30% (wheat); 40-55% (pulses) and 25-40% (cotton), whereas at high population density the damage reaches to over 60%. Likewise the wild boars are reported to inflict 23-38%, 5-14%, 12-35% and 6-26% damage to major crops in UP, HP, Rajasthan and MP, respectively. Except for a few sporadic reports, no comprehensive information is available on pestilence of these animals to the agriculture. It is therefore need of the hour to understand the basic ecology and behavior, pestilence of these wild species to develop technologies to mitigate crop losses to agricultural production systems.

### **Management Issues**

The damage caused by wild mammals like Nilgai (blue bull), wild boar and monkeys to agriculture has become a matter of serious concern and needs to be managed effectively. Farmers across the nation are suffering badly due to their menace. Since these animals are protected under Wildlife Protection Act, their management through non-lethal approach is the pre requisite to minimize the crop losses as well as man animal conflict.

**Legal issues:** These animals being protected by Indian Wildlife Protection Act 1972 and Biodiversity Act 2004, hunting or using any lethal method is legally barred. However in extreme situations the State Governments



has been empowered to issue the licences/orders for killing the problematic animals following proper procedure. The Act states, *'The Chief Wildlife Warden or the authorized officer may, if he is satisfied that any wild animal specified in Sch. II Sch. III or Sch. IV has become dangerous to human life or to property (including standing crops on any land) or is so disabled or diseased as to be beyond recovery, by order in writing and stating the reasons therefore, permit any person to hunt such animal or cause such animal to be hunted'*. Gujarat has appointed *Sarpanches* of 1545 villages as Honorary Wildlife Warden under Section 4(1)(bb) and empowered Chief Wildlife Warden under Section 5(2) to delegate his powers to *Sarpanches* under Section 11(1)(B) to allow hunting of Nilgai in their respective areas. Similarly in the states like Haryana, Uttarakhand and Uttar Pradesh also the Government has empowered DFOs, District Collectors and Block Development officers to issue permit to kill the problematic nilgai in extreme situations.

**Management techniques:** In many countries killing of problem species, like wild boars are permitted in special cases. In USA wild boars are controlled by hunting, caging and shooting. Poison baits on a large scale is a widely used method in Pakistan for managing the wild boars. In Bhutan on the other hand, trained group of farmers are employed in hunting the wild boars. Italy is a country where wild boar menace is kept under check by using rodenticides. In some countries like England, Poland, Russia and Japan it is very common to control wild boars by poisoned baits, hunting, shooting, catching, electrocution and translocation etc. Despite the above methods being effective none of them are applicable for Indian conditions as wild boars have been listed in Schedule III of Wild life Protection Act. In the light of such situations development of management practices for higher vertebrates in India need to be strategic, logical, and economical and above all must be legally sound in the light of the Act.

### **Initiatives taken by ICAR**

Keeping in view the severity of the problem in agriculture associated wild animal species; ICAR has launched an All India Network Project on Vertebrate Pest Management during XII Plan period. Besides studies on birds and rodents, management of higher vertebrates is an important component of the Network. The Project envisages to undertake detailed studies on ecology and management of three most important wild animal species, viz., Nilgai (*Boselaphus tragocamelus*); wild boar (*Sus scrofa*) and monkey (*Macaca* sp) to minimize the crop losses *vis a vis* farmer - animal conflict in agricultural landscape.

In this regard AINP on VPM (ICAR) organized a Brainstorming Session on higher vertebrate pest at Delhi on 21.02.2015 to discuss the Way Forward to deal with these animals within the framework of loss of agricultural production, legal instruments, man-animal conflicts, etc.

### **Technological Options**

**Wild Boar management:** AINP on VPM through its center at PJTSAU, Hyderabad has developed some measures to control the wild boar damage in agricultural fields. However these methods need to be tested further across different agro climatic zones to validate their effectiveness in reducing the damage by wild boars. These methods are briefed as under

#### **Barrier crops**

- High density planting of castor around maize and sorghum
- High density planting of safflower around ground nut

#### **Physical barriers**

- Erecting of circular razor wire around the crop
- Erecting of HDPE fish net around the crop

#### **Traditional methods**

- Spraying of local pig dung solution
- Human hair as deterrent
- Erection of used colourful saris around the crop fields
- Burning of dried pig dung cakes
- Erecting three rows of *niwar* soaked in kerosene
- Erecting coconut ropes soaked in mixture of sulphur and pig oil around the crop fields



**Fig 4. Planting safflower as border crop to protect ground nut from wild boars**

Planting of thorny bushes cacti around crop fields.

Creation of light and sound through burning fire crackers, making sounds through local drums, empty tins, making bonfires and shouting.

Use of local dogs for scaring away

### **Nilgai and monkey management**

For managing the species like Nilgai and monkeys in crop fields, some methods available in literature (listed below) have been identified which needs to be field tested under AINP on VPM.

### **Methods for Nilgai management**

- Spraying of male excreta around the crop bunds
- Spraying of repellents like egg solution, castor oil and phenyl solutions around the crop
- High density planting of castor as barrier crop
- Bioacoustics
- Repellents: Predator odours (reduced deer damage by 60%) in North America.
- Use of Fear provoking stimuli : (i) Visual (ii) Auditory and (iii) Olfactory (predator odours)
- Traditional chain link fencing and pulsating power fencing : (i) Effective world wide (ii) Eight strand power fencing effective in containing nilgai (iii) Cost per km 2.50 lakhs
- Capture and Translocation : Dropnets & net guns etc
- Chemical capture: (i) Etorphine hydrochloride (ii) Xylazine hydrochloride in combination with Ketamine and (iii) Medetomidine hydrochloride in combination with Ketamine.



**Fig. 5. Circular razor wire fence around the crops**



**Fig. 6. Planting spiny cacti as barrier around fields**

- Fertility control (i) Mechanical and surgical techniques (ii) Endocrine disruption (iii) Immunocontraception
- Planting of spiny cacti at edges (Fig 6).

### **Methods for Monkey management**

- Use of chemical and botanical repellents
- High density planting of non-preferred crops on borders
- Erection of animal effigies
- Selective de-branching of shade trees in coffee and cardamom plantations
- Immune-Contraception Vaccine (Gonadotropin baits)
- Capture and Translocations

# Wildlife and human impacts in the Gir landscape

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## Summary

The only free-ranging population of the Asiatic lion (*Panthera leo persica*) is found in the Gir Protected Area (PA), located in Saurashtra region of Gujarat state. The Greater Gir landscape which includes the current expanse of Asiatic lion range extends across Amreli, Junagadh, Gir Somnath and Bhavanagar districts. Agriculture and animal husbandry is the mainstay of the economy in this region. Both these sectors have seen remarkable improvement owing to several schemes implemented through innovative Gujarat state government policies in recent times. The outcome of successful protection and management of Gir PA has resulted in growth in wildlife population within the PA on the one hand and on the other, changing cropping patterns, altered land-use and land encroachment at the PA boundary, has resulted in greater movement of both carnivores (lions and leopards) and wild ungulates outside the PA leading to situations of human-wildlife conflict.

The paper discusses the positive and negative aspects of human and wildlife interaction both within and outside the PA and the varied priorities and approaches to conservation planning in either zone. Wildlife conflict in agro-pastoral landscapes outside PA impact both farmers and wildlife species causing financial losses leading to significant social and cultural changes resulting in transformation in conservation ethics and outlook.

The paper emphasizes the need for all government departments to work synergistically to achieve common goals and optimize resources and planning. Agriculture department should share responsibility for reducing crop raiding menace by wild ungulates through support of research and technological innovation for mitigating losses. They should specifically invest in research in understanding behavior and ecology of these species so as to be able to eventually come up with scientific solutions to address the problem. These efforts could be in collaboration with the forest department. Providing relief to farmers would also benefit forest and wildlife conservation, and, in this case sustain local peoples' tolerance and empathy towards the conservation of endangered Asiatic lion.

## Introduction

### Agriculture sector in Gujarat State

Gujarat's economy has been outperforming the rest of the country since 1990 largely because of rapid industrial growth. The state has achieved a remarkable progress in key sectors like energy, industry and agriculture since the 10th Five Year Plan period *via* strategic development programs.

The Gujarat state has an agricultural economy; the total crop area amounts to more than one-half of the total land area. The State is endowed with abundant natural resources in terms of varied soil, climatic conditions and diversified cropping pattern suitable for agricultural activities. On the basis of varied agriculture and climate characteristics, 7 sub agro-climatic zones are recognized.

Gujarat is the chief producer of cotton, groundnut and tobacco. Wheat, jowar, bajra, maize, tur, paddy and gram are other cultivated crops. Since 1999-2000 semiarid Gujarat has shown a remarkable annual growth of 9.6% per year due to several innovative agriculture development programs, improved infrastructure, improved irrigation both canal irrigation and groundwater irrigation particularly in the semi-arid regions. Semi-arid regions of Saurashtra and Kachch have particularly benefitted from these efforts with the result that these areas have out-performed the canal irrigated South and Central Gujarat. Gujarat is also one of the leading states in export of processed foods and high value products. These industries are thus other important sources of revenue from agriculture sector.

The analysis on change in cropping pattern in Gujarat reveals that share of area under cotton and wheat crop to total gross cropped area has significantly increased during last two decades. The increase in area under horticultural crops has also contributed considerably towards the change in cropping pattern of the state. The state occupies is among the country's top producer of fruit, vegetable and spices.

The adoption of cooperatives in Gujarat is widely attributed to much of the success in the agricultural sector, particularly sugar and dairy cooperatives. Gujarat is the largest producer of milk in India. Dairy farming, primarily concerned with milk production, functions on a co-operative basis and has more than a million members. Animal husbandry and dairying have played vital roles in the rural economy of Gujarat.

### District Junagadh and Amreli

Junagadh and Amreli districts are semiarid regions of southern Saurashtra agro-climatic zone with black soil and typically cultivating rice, maize,

sugarcane, wheat, gram pearl millets, sorghum, groundnut, sesame, cotton, pulses, rapeseed and mustard. The two districts are highly populated with agriculture as the backbone of the economy. Mineral based cement industry, fish processing, agriculture based industries such as sugar, edible oils, solvent extraction processing are some of the chief industrial activities of the region. Bhavanagar district in addition to agro-economy has thriving industries owing to significant reserves of limestone and lignite. The key industries in the district include: soda ash, ship breaking, ship-building, plastic manufacturing, diamond polishing and cutting, chemicals, engineering products, foundry, salt, tobacco products, rubber, textile machinery and agro-product based units.

### **Gir PA: location and characteristics**

The Gir WLS and NP (Gir PA here after) is located in the southern part of the Kathiawar peninsula, in the state of Gujarat in western India, extending across districts of Amreli and Junagadh, at 20° 57' and 21° 20' N latitude and 70° 27' to 71° 13' E longitude (Fig. 1). The recently expanded Greater Gir landscape now includes Amreli, Junagadh and Bhavanagar districts and is currently managed by four territorial forest divisions.

Chital *Axis axis*, Sambar *Cervus unicolor*, Nilgai *Boselaphus tragocamelus*, Chinkara *Gazella benettii*, Chousingha *Tetracerus quadricornis*, wild pig *Sus scrofa*, Porcupine *Hystrix indica*, Common langur *Presbytis entellus*, Peafowl *Pavo cristatus*, Rufous tailed hare *Lepus nigricollis ruficaudata* are the important resident prey species of carnivores, namely lions (*P.l.persica*) and leopards (*P.pardus*).

This 1400 Km<sup>2</sup> forest area is compact but not free of human presence or disturbance. Within the PA, indigenous pastoral community called *Maldhari* has been coexisting with lions for over a century. About 4500 people in 14 forest settlements with a livestock of over 4000 are resident within the sanctuary area. Over 2000 *Maldharis* with about 12000 livestock live in settlements called *nesses* across the PA. There are 97 peripheral villages with over a lakh human population and over 90,000 livestock within 5km of the PA. The economy in this landscape is largely driven by farm based agriculture, horticulture and animal husbandry. The Buffalo and cattle of this region are of high market value ranging from Rs.10000 – 30000 and Rs. 2000 – 8000 respectively.

### **Overview of Human-wildlife Conflict (HWC) in Gir landscape**

#### **HWC within PA**

#### **Negative impacts for people**

Each household had an average (SD) of 13 (11) buffalos and 2.5 (3) cattle of which productive livestock were 4 buffalos and 1 Cow per household (Meena *et*



*al.* 2009). About 60% of livestock mortality was due to predation by lions (Meena *et al.* 2009). Thus, such losses to individual household could be substantial especially if it is a productive buffalo or cattle.

On the other hand, from the management point of view, overall only 4% of total resident livestock are lost to predation and this is offset by free-grazing rights and use of other forest resources. Nevertheless, partial monetary compensation is also provided for losses due to predation.

### **Negative impacts for conservation**

Habitat level changes occur due to over-grazing, competition of livestock with wild ungulates, and other malpractices – harvesting of fodder and fuel-wood and collection and selling of top-soil as manure (Berwick 1974). There exist other indirect threats due to presence of livestock in the forest such as water contamination and transmission of diseases at water-holes.

Recognizing the negative effects of livestock on habitat and wild ungulates and the conflict that arose due to livestock killing by lions in the early 1970s the Gir lion Project was launched and about 500 *Maldhari* families were relocated. Relocation of *Maldharis* resulted in vegetation succession and surveys indicated that late seral stages were more preferred by ungulates and they in turn responded positively to this transformation (Khan 1995). Therefore, habitat revival brought about increase in population of wild ungulates which in turn resulted in greater consumption of wild prey by lions (Meena *et al.* 2012).

Recent spread and infestation of weeds has been attributed to ill-effects of grazing and presence of livestock in spite of observations that severe negative impacts of nesses exist only up to 500m from the ness vicinity. Among ungulates, only chital have been shown to be more tolerant to presence of people and livestock in the forest while other ungulates show varied responses.

### **Moderate approach to mitigation of livestock impacts within PA**

While livestock grazing reduces above ground biomass, moderate levels of grazing facilitate forage availability to chital (Dave 2008). This indicates that that regulated levels of grazing with optimum livestock densities may be a good approach to managing livestock presence to benefit wild ungulates (Dave 2008). Further, livestock still contribute a significant proportion of biomass consumed by lions (Meena *et al.* 2009).

Thus, even though there are several negative impacts for both people and forest conservation due to coexistence in this habitat, regulated human and livestock population within Gir may yet be mutually beneficial in the short-term (Dave 2008). However, for long term conservation goals the planning has to focus on wildlife habitat and species within the Gir PA but carried out in a phased out manner.

## **Human-wildlife Conflict in the PA periphery**

Lion population has shown consistent growth in the last 3 decades. Since 1995 it has been noted that lions have taken permanent residence in habitat patches outside PA. There has been a growth in this population as well to the extent that currently about 35% of the lion population exists outside PA (Figure 2).

In recent times, the conversion of *Gauchar*, community, panchayat, revenue wasteland and forest lands into crop fields has resulted in increasing the pressure on forest for resources (Vijayan and Pati 2001).

Lack of natural habitats in the buffer zones has deprived wild animals of refuge sites and therefore their movement in human habitations outside PA has also increased (Vijayan and Pati 2001). Thus, altered cropping from traditional crops like groundnut to mango and sugarcane -103% and 87% respectively within a ten year period – has increased interaction with people and wildlife at the interface areas thereby increasing the scope for conflict (Vijayan and Pati 2001).

## **Proximity to forest: positive impacts for people**

Villages within 15km radius of Gir PA have relatively higher irrigated land, more cultivated area of farm-based crops and horticulture crops generating nearly 3 times greater crop productivity owing to the indirect environmental benefits they derive from Gir PA (Pandya *et al.* 2001). Significantly higher rainfall is received within 15km of Gir PA while water from 7 perennial and other seasonal rivers and streams managed in reservoirs and check-dams supply water throughout the year to crop-lands outside the PA (Pandya *et al.* 2001). The presence of the forest is not only responsible for improved water availability but also contributes substantially to improvement in water quality and reduction in salinity ingress, and carbon sequestration (Pandya *et al.* 2001). Gir PA also plays a role in providing fuelwood, fodder and grazing land for livestock within and outside PA (Pandya *et al.* 2001). Wildlife tourism is another income generating activity thriving in the western part of Gir PA chiefly benefitting Sasan Gir and other villages in Talala Taluka. Other livelihood opportunities and resources are available to the local people owing to their inhabiting close to PA.

## **Negative impacts for people**

Carnivore attacks, including attacks by both lions and leopards, on humans has increased. On an average about 22 such cases occur each year. Livestock losses to carnivore predation have also increased in the past decade both in terms of frequency of predation and the extent of predation incidents

from the PA boundary have increased. On an average about  $1995 \pm 12.46$  livestock are predated annually in the entire Gir landscape.

Wild ungulates chiefly Nilgai and Wildboar cause enormous losses to farmers due to crop raiding. Chital, Sambar, chinkara are also responsible for crop losses. In the entire periphery of Gir each taluka on an average lost about 34% of annual crop productivity due to feeding and trampling by wild ungulates. Conservation attitude surveys indicated that people consider crop raiding and crop loss by wild herbivores to be a bigger threat than risk posed by carnivores and economic loss due to livestock predation to the extent that many considered presence of lions and leopards as important in checking the wild herbivore population (Meena *et al.* 2014).

### **Negative impacts for conservation**

Movement of wild animals outside PA makes them vulnerable to accidents, poaching and retaliatory killing. In the period of past five years, there have been records of unnatural mortality of 121 leopards and 25 Asiatic lions in and around Gir PA (Dasgupta 2016). Other causes for unnatural deaths included falling in open wells, electrocution caused by electrified fencing in farmlands and road accidents. Land encroachment, immense pressure on forest resources are other impacts of people in the interface areas on wildlife habitats.

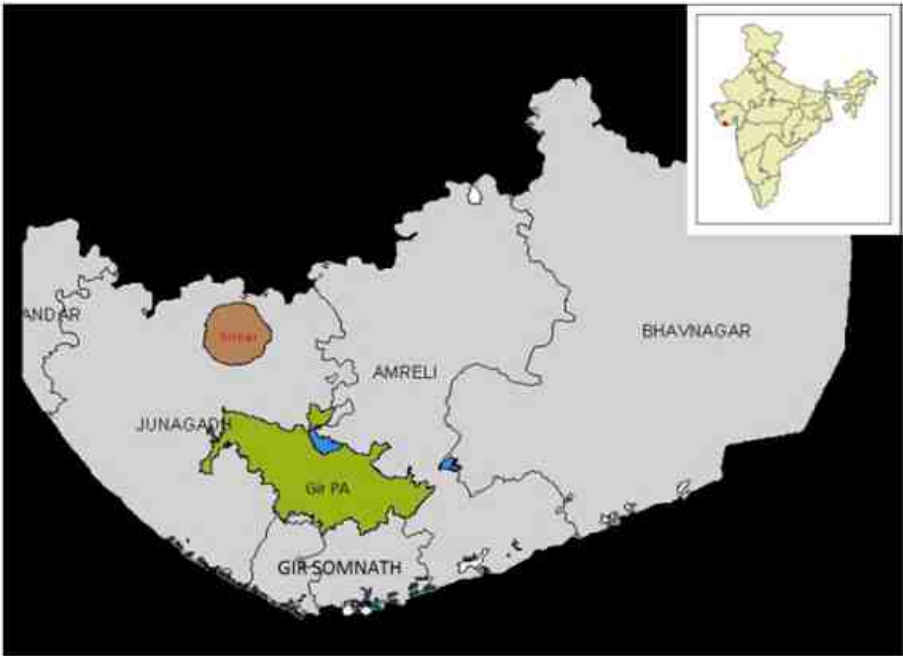
### **Mitigation**

Spill-over wildlife populations seek forage, shelter and other resources for survival outside the forest boundaries in the agro-pastoral landscapes. Crop loss and livestock loss due to wild animals cause setbacks in lifestyle and incomes for people. Other indirect effects, such as the fear caused by presence of carnivores in farmland areas affects work resulting in loss in man-days and money (Meena and Kumar 2012, Meena 2012).

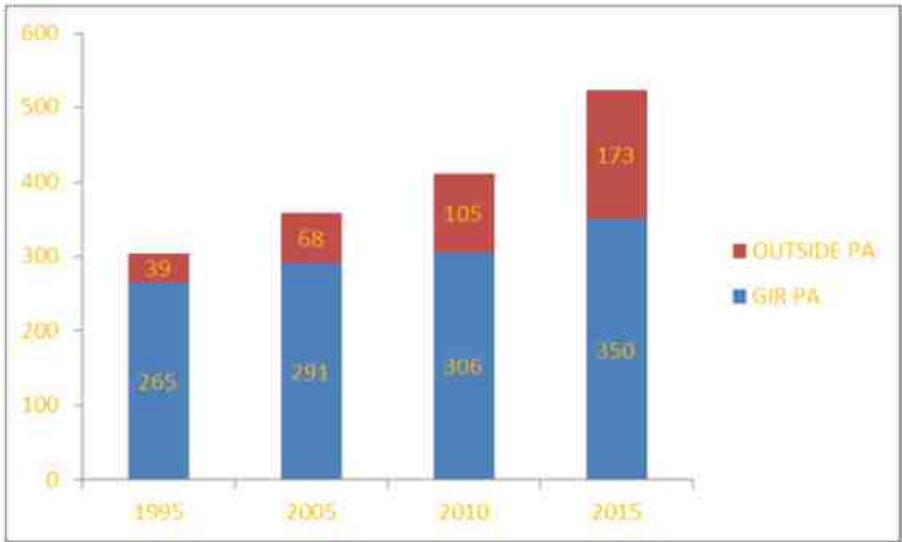
As mitigation measures, the Gujarat Forest Department partially compensates monetary losses caused by carnivores and wild ungulates, provides financial aid for constructing boundary wall around wells and protective fences in farmlands. The department also captures and relocates injured wild animals that either pose a threat to human safety or are injured or trapped in the village vicinity outside the PA boundary (Meena and Kumar 2012).

### **Conclusions**

We have seen how agriculture and animal husbandry are the chief drivers of local economy in the Gir landscape. Four important districts contributing vastly to the agriculture produce and economic well-being of Gujarat state are influenced both positively and negatively by the Gir forest.



. Gir Protected Area location across Junagadh, Amreli, Gir-Somnath and Bhavnagar districts. In set shows location in the western part of India.



Increase in population of Asiatic lion in Gir PA within and outside sanctuary

While forest and wildlife conservation management is their primary objective with a specific responsibility of saving the only endangered population of Asiatic lion, the Gujarat Forest Department is compelled to perform varied roles beyond the scope of this mandate particularly outside PA. These tasks include human-wildlife conflict (HWC) mitigation, socio-economic and livelihood schemes benefitting stake-holders within and outside PA, tourism management and research. The task of managing and offsetting agriculture losses due to wild ungulates is increasingly coming under focus under HWC management.

Agriculture, tourism, forest departments seem to work in different silos with different outlooks but yet having overlapping interests – achieving targets of one is likely to influence or spur the functioning of the other. It is time for these departments to coordinate, cooperate and optimize resources to successfully achieve their respective goals. Agriculture sectors should now begin to contribute in terms of research to lessen losses and also compensate losses caused due to wildlife. Strategies for controlling wild population, altering cropping patterns, mitigation aids can be contributed by agriculture sector in the future.

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# **Decline of Bird Diversity in an Urban Layout in Residential Bengaluru, India - A Human-bird Conflict (1974-2014)**

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Birds of Bengaluru have been documented in the last four decades by several bird watchers mostly amateurs. The current bird count in Bangalore stands at 496. Bangalore in south India (12°58'N 77°34'E) is a fast growing urban city comprising of buildings, parks and several tanks as well. It also has a peri-urban outskirt with a part of it forming a scrub jungle, the Bannerghatta National Park.

One of the layouts namely, Domlur 2<sup>nd</sup> stage, an extension of Indiranagar layout is the focus of the present study. Here, birds were documented in random notes from 1972 by the first author. The notes were tallied for 1974-75, 1984-85, 1994-95, 2004-05 and 2014-15 and the results of these in terms of species richness are discussed. It was found in 1974 that the number of species seen was 39. At present, a steep decline of bird numbers has occurred. As such, this layout prior to urbanisation was a partial wetland and vegetable growing area. A portion of Bangalore sewerage flows through it. Considering the total percentage of Bangalore's bird fauna, the number 39 was only a partial percentage of 7.86%. Even this percentage by 2014-15 declined to just 12 species accounting to 2.42%. It is interesting to find that the number of bird species seemed to have a negative trend with the number of buildings or houses which increased from 2 in 1974-75 to 314 in 2014-15.

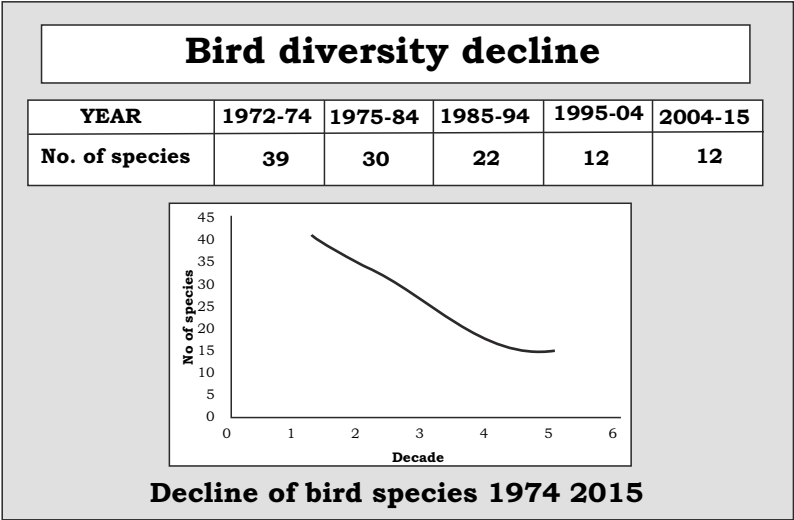
With increase in number of houses, there was increase in urbanization and related activities like pollution, population increase, vehicles and people moving around. Consequently the bird numbers also showed a decline. In table 1, we see nine birds namely Black Kite, Brahminy Kite, Rock Pigeon, Asian Koel, House Crow, Tickell's Leaf-warbler, Common Myna, Jungle Myna, Purple-rumped Sunbird which could be termed as residential species which are able to tolerate urbanization. Interestingly, there would have been a further decline from 12 to 9 in 2014-15 but for the fact that the woody parks that had trees planted by 1990s attracted the White-Cheeked Barbet, Tailor bird and Red Whiskered Bulbul (Table 2).

This is based on amateurs rambling notes and the authors suggest that across the country, such long term notes on species richness on a temporal scale

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can be compiled. Bird diversity decline is sure an indication of habitat loss due to agriculture/ horticulture/ urbanization or a combination of these. To halt the decline one indication this study has shown is the restoration of trees. This can be extrapolated to suggest that other habitat restorations would augment bird species richness in order to balance human-bird existence. We should be more wary of their presence and leave patches of refugia within urban areas to prevent decline of bird species.



**Bird diversity decline**

**Bird species which were attracted back (post-garden) (3)**

White-cheeked Barbet	<i>Megalaima viridis</i>
Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>
Tailor bird	<i>Orthotomus sutorius</i>

**(Marginal restoration in bird diversity)**

Table 2: Birds attracted back to the study area after 2014-15.



Red-whiskered Bulbul



Tailor Bird



White-cheeked Barbet

Photography by  
S. Sridhar

## **Proceedings of workshop on Human Wildlife Conflict in Agro-pastoral Contexts**

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Human wildlife conflict (HWC) is on the rise globally, and construes one of the bigger environmental problems facing India. HWC in India manifests itself in several ways, notably, wildlife poaching, retaliatory killing of/injury to wildlife species, crop raiding, livestock predation by wildlife species, injury to humans or human mortality, destruction of property, houses and buildings by wildlife. Of these, wildlife conflict in agro-pastoral contexts has been the subject of much debate, in-depth study and great concern nationally, not only for its impact on farmers and agricultural production, but also for the ill consequences to the wildlife. HWC involves multiple stakeholders and multitudinous socio-cultural and environmental issues, hence needs a holistic understanding of the history of wildlife, crop and livestock raiding, its nature and consequences and techniques to mitigate the crisis.

In order to address these issues, a workshop on Human - Wildlife conflict in Agro-pastoral Contexts, jointly organized by Indian Council of Agricultural Research and National Institute of Advanced Studies, Bengaluru, was held during 11-12 December, 2015 at ICAR - National Bureau of Agricultural Insect Resources, Bengaluru. Major thrust in the workshop was on wildlife conflict related to monkeys, wild boar, nilgai and elephant, that receive little attention in public discussions, yet cause enormous economic and human losses to small farmers. The workshop also deliberated to understand different dimension of human-wildlife conflict in agricultural ecosystem and find way to mitigate the losses caused to agriculture by wildlife, with minimum losses to wild animal. The workshop was attended by scientists from ICAR institutes, state agricultural universities, National Institute of Advanced Studies, Indian Institute of Science, Asoka Trust for Research in Ecology and the Environment, independent researchers, State forest department officials of Karnataka, Andhra Pradesh and NGO from Himachal Pradesh.

Dr. Abraham Verghese, Director, ICAR – National Bureau of Agricultural Insect Resources, Bengaluru welcomed the gathering and Dr P. K. Agrawal, Assistant Director General (NASF) ICAR briefed the objectives of the workshop. In his inaugural address, Baldev Raj, Director, NIAS, Bengaluru elaborated about the genesis of the workshop. He informed that the idea mooted by him to hold the workshop on human-animal conflict in agro-pastoral context was well received by Dr. S. Ayyappan, Director General (ICAR) and

Secretary DARE. This led the NIAS and ICAR to coorganize the workshop. He observed that workshop would provide a better understanding to handle the need and challenges related to human and wildlife co-existence (in place of conflict) and food supply. He also emphasised that a mission approach is needed in addressing the issues and there is need for creation of leaders at young and senior level to deal with the challenges. He was of a view that with the population explosion, it was difficult for human and other species (wildlife) to co-exists in harmony. This is specially when human mind is capable to device tools for destruction. He called upon to initiate evidence based research, which can make the justification for the organizing workshop.

Dr. Baldev Raj suggested for greater reliance on use of cutting edge technologies like sensors to generate big data on wildlife which will contribute to better understanding on issues related human-animal conflict. He concluded by reminding the challenges that climatic change would pose in understanding the current situations of the wildlife problems. He also called upon the group to unfold the multi-perspective point to asses and to understand the planned policies to address the challenges.

Dr. V. S. Ramamurthy, NIAS called upon the need for a change in perception of human and wildlife conflict and emphasised that coexistence is the only way forward. Technologies generated has pros and cons. He quoted the impact of wireless technologies on honey bees which was observed to have adverse effect on pollination.

In his keynote address, Dr. S. Ayyappan, DG (ICAR) and Secretary (DARE) noted that with new problems stemming, it is essential to have collaboration among disciplines, organizations and stakeholders on human-wildlife conflict on agro-pastoral context. He expressed his concern about the losses being incurred in agriculture. He informed that agriculture in India was experiencing paradigm shift with 250 million tonnes of food production and 137 million litres of milk but there still exists a gap. Reduction of losses due to insect-pests, animals, post-harvest loss and zoonotic diseases is quite huge. He urged that decline in agricultural production due to wildlife damage viz., wild boar, nilgai, rodents and birds may be addressed during the workshop and the possibilities of evaluating the sensors and other gadgets to mitigate the problem arising due to wildlife be supported through extramural grants from ICAR.

He also felt that the group should address the area of wildlife medicine. He touched upon the wildlife damage across the regions of the country. Main reason for the conflict is due to habitat loss and degradation. He called upon for

clear policies in India on line with US wildlife acts/policies. He gave an overview of conflict mitigation strategies like physical barriers, acoustic and chemical deterrents developed by ICAR under the All India Coordinated Research Project on Vertebrate Pest Management. These technologies have helped to a good extent to overcome damage caused by wildlife/animals/birds in food production. He also, stressed the need for developing a mitigation techniques database that would aid to address the issue. Participation of public, private organizations, NGO's and Panchyats will effectively help to overcome the human-wildlife conflicts and its impacts on agriculture.

The inaugural session was followed by technical sessions. The first session was on "Wildlife and crop damage", was chaired by Dr. Baldev Raj, Director, NIAS.

Dr. K.L.M. Pathak, Deputy Director General (Animal Sciences) ICAR, mentioned ten prime zones in the Indian sub continent that recorded Human - Wildlife conflict. Little importance was laid on evaluating the efficacy of management measures developed to overcome the human animal conflict in agro ecosystems. He reiterated that measures are to be developed based on-bioecology of the pest species within its physical and biotic environment. The need to develop cost effective and eco-friendly technologies for sustainable crop productivity without violating Wildlife Protection Act will be a welcome approach to solve the problem. There is a need to compare the cultural and social views of people across the country on issues related to wildlife. He cited the practice followed in Hong Kong and Japan on restoration of habitats, public being stopped from feeding and, castrating male animals that has led to population control of animal pests.

He informed the initiatives taken by ICAR to establish All India Network Project on Vertebrate Pest Management by merging the existing All India Network Project on Vertebrate Pest Management on Rodent control and Agricultural ornithology. General issues related to target animals for research and development were discussed. Risk assessment, ecology of pest species, technology options both short and long term, formation of national expert group and creation of database were discussed.

He was of the opinion that the technologies generated for wild life management are to be validated through KVKs on pilot basis. The success of bio-acoustics – a potential method to deter wild boar in reducing crop damage to the extent of 80 – 100% in 35 farmers' fields across the country was discussed. Though, vertebrate pest management tools were available, lack of sustained

efforts at local level, strong religious sentiments against killing, complicated policy and administrative issues, high cost of eliminating the animal, lack of coordination with district authorities, lengthy procedure for declaration of wild animals as vermin were the prime reasons for the problems to exist. It was decided that multi location trials have to be laid to validate the vertebrate pest management. Capacity building in VPM through extensive training to Agricultural Scientists in Wild Life Protection laws and organization of awareness programmes in VPM to inculcate sense of social responsibility in adopting VPM practices were discussed.

The only free-ranging population of the Asiatic lion survives in the Gir PA, Gujarat. The semi-arid forest habitat is surrounded by agro-pastoral landscape which forms the backbone of economy of the Saurashtra district and also an important contributor of the booming dairy and agriculture sectors of Gujarat's economy.

Dr. MeenaVenkataraman, Carnivore Conservation & Research (CCR), Mumbai delivered a talk on Carnivore- livestock predation in Gir. Livestock is an important component of lion's diet and therefore the talk highlighted the issues related to conservation management, human interventions and livestock predation. The issues and management approaches to resolving human-wildlife conflict within and outside PA were compared. About 30% of current lion population survives in human landscape outside PA and greater focus is required in these areas. Improved husbandry and monetary compensation help in reducing losses due to livestock predation. For farmers, reducing the substantial losses due to crop-raiding by wild herbivores would have to be prioritized. The presentation emphasized the need for involving various stakeholders and government agencies including forest and agriculture departments in management planning. These efforts would help to maintain the existing positive attitude towards forest and lions and ensure survival of the endangered lions.

On a query by Dr. Abraham Verghese, if the Gir forest has crossed the carrying capacity of Lion, the speaker informed that Gir forest has gone beyond its carrying capacity. One of the approach for controlling the lion population is to go in for translocation, but that requires political will. She informed that though Madhya Pradesh was identified as a suitable location for translocation of the lion, Gujarat Government was unwilling to decide accordingly. Dr. Baldev Raj wanted to know as what would be the scenario after 25 - 30 years. The speaker observed that there was no model available currently to forecast the scenario after 20 - 30 years. During the deliberations it was felt that degradation of the prey base was the reason for the shift of lions to livestock's and that the disturbance posed by tourist in their natural habitat leads to behavioural shift.

Dr. Abraham Verghese, Director, ICAR - NBAIR, Bengaluru delivered a talk on Bird - Man conflict: A case study in Bengaluru. He informed that conflict between bird and man in a highly urbanized city of south India has been documented for 40 years. Data reveals that there is a gradual decline from prevailing 39 species in 1972-74 to 12 species in 2004 and this remains unaltered till 2014. He informed that birds are highly sensitive to their habitat fragmentation, and that their survival in this environment depends on their critical threshold of tolerance. The most sensitive species got succumbed to urbanization while tree loving ones could show revival due to growth of urban city oriented parks. Marginal restoration of white-cheeked barbet, red whiskered bulbul and tailor bird became possible after the growth of peri-urban horticulture. In order to eliminate conflict and improve the co-existence it was suggested for the diversification of habitat. Birds are potential bio-control agent but the limitation on exploiting them for this purpose is that the ecological consequences like breeding for birds is problematic as they are highly moving. This problem can be overcome if habitat dependent release is performed.

The impact of wildlife damage on farmers was discussed during the second session. Dr. Nitin Rai, ATREE, Bangalore touched upon conservation policy, wildlife deprecation and livelihoods. He informed that protected area notification in our country has dropped from 1980. The impact of conservation policy had led to displacement as evinced from Biligiri Rangaswamy temple animal reserve area. Conservation of wildlife through the WLPA 1972 brought in ban on hunting and this caused the farmers to switch over to coffee plantation. Increased dependence on wages led to decline in income and food security. He emphasized that restrictive policies had adversely affected household incomes. His interactions with the native forest tribes like the Soligas was discussed. He presented their views that suppression and control of fire in wild areas has resulted in the increase in *Lantana* and hemiparasites causing reduction in the availability of a major forest produce. Decentralized governance and restitution of rights might decrease 'conflict' and alternative possibilities for mitigation were discussed. Conservation of wildlife through the WLPA 1972, recognition of Forest Rights Act 2006 which gives tribal and forest dwelling communities the rights to cultivate, use and manage forests were deliberated.

Dr. Sindhu Radhakrishna, NIAS, Bengaluru delivered a talk on "Farmers perception regarding problem wildlife species". She introduced the outline of conflict, physical separation of species and resources, guarding assets, habitat use and behaviour modification. She touched upon the conflict species, humans, use of buffer resources, lethal/non-lethal control of conflict species



and, reducing costs of conflict. She deliberated on single livelihood strategy versus alternate sources of income. The social influence, folklore, societal changes, attitude towards animal in resolving conflict were discussed. Two case studies involving the man animal conflict in *Rhesus macaque* and the *Bonnet macaque* were presented. She spoke on public knowledge, attitude and tolerance to animals. To understand this, the issue of rodents and monkeys were considered. Though rat is a mooshakvahan, its menace in godowns were not tolerated but monkeys causing a menace is left unharmed. The forum discussed the translocation, herd size, behaviour and stringent drawbacks of the animal and compared them with the rodent menace.

The session III was on mitigation strategies for wildlife agricultural damage. Dr. Radhagopalan, Independent Researcher from Goa delivered a talk on cropping techniques to mitigate human wild boar conflict. She talked about agricultural crop depredation by hardy, omnivorous and quickly adaptable *Sus scrofa* as a major problem for farmers of Rayalseema. The wild boars were largely residing in the mixed dry deciduous forests of Horsley hills range and scrubland area on the fringes of the forest. Successive drought over a period ten years made them to move out of the forest, subsequently their population increased largely due to restrictions imposed on hunting, lack of predators and their access to irrigated crops. As cultivated crops are easy and rich source of nutrients the wild boar find them tempting and this leads to human animal conflict. The management strategies involving physical, agro-ecological and pheromonic strategies being practiced by farmers to ward off the wild boar menace were discussed. Though the management methods in vogue are effective, she emphasised that for the scenario to change from conflict to coexistence, much attention is needed on improved agro-ecological approaches.

Dr. V. Vasudeva Rao, ANGRAU, Hyderabad delivered a talk on Bioacoustics as a wildlife damage mitigation technique. He informed that the main reason for vertebrate problem in agriculture was due to degradation of habitats, non-availability of preferred dietary items in natural habitats, depletion of natural predatory pressure, increasing populations, changing cropping patterns, providing excellent cover and suitability for wild animals, higher adaptability of the species. He gave a detailed account of the bioecology of wild boar in agro-ecosystems. On distribution pattern, they preferred bush jungles, forests and agricultural crop lands. He informed that the damage by wild boar on agricultural crops were on rise and the farmers faced severe loss due to the damage caused by them. He informed that as per IUCN wild boar was listed under least concern, while in IWPA it is under Schedule III.

Dr. Rao informed that many management measures for the wild boars were developed under All India Network Project on Agricultural Ornithology. They include physical barriers, biological barriers, non chemical practices, traditional methods and applications of bio-acoustics. Among the methods developed, bioacoustics is promising as they use the natural sounds of predators, distress/ alarm calls of target and closely related species of target animals at a fixed volume of 110db. These devices when placed in the field had an effect upto 4-5 acres and this could be easily adopted and are economically viable.

Dr. R.S. Tripathi, Network Coordinator on Vertebrate Pest Management covered the mammalian diversities in India. He mentioned that the birds and mammals are considered as vertebrates pests on agriculture and horticulture crops. The distribution, crop damage and management methods for nilgai, a serious vertebrate pest on crops was discussed by him. In addition to this sloth bear, wildboar, Rhesus macaque and Bonnet macaque were of concern in causing damage to crops.

Considering the economic damage caused by these vertebrate pests, a report of National Institute of Disaster Management at Himachal Pradesh revealed that farm produce worth Rs. 500 crore was lost annually due to damage to crops by wild animals. He also made a mention of the the reports of Kheti Bachao Andolan Himachal Pradesh which states that Himachal Pradesh lost crops worth Rs. 2,200 crore between 2007 to 2012 due to monkey damage. This was complimented by data provided by State wildlife department on monkey population in Himachal Pradesh that increased from 61,000 during 1990 to 317,000 in 2004.

He informed that during the year 2010, farmers of Chainpur and Saharsha in Bihar formed an association, 'Bandar Mukti Abhiyan Samiti'. On monkey menace in Karnataka, he informed that over 800 small farmers gave up cultivation in the Karkala taluka near Mangalore after monkeys destroyed 75 per cent of crops in the area in 2012. As a result, over 57.0 ha of fertile land lies fallow in the taluka today. According to him the management measure for monkey menace involves translocation, culling, sterilization, ultrasonic guns, bioacoustics, use of chemical and botanical repellents, pyro-techniques, non-preferential crops in high density planting as border (Hairy bhindi, Thorny brinjal, Chillies & Ginger), animal effigies and Immune-Contraception Vaccine (Gonadotropin baits).

The challenges in higher vertebrate management is lack of scientific data base on species, its ecology, behaviour, pestilence, lack of sustained efforts at local level, strong religious sentiments against killing, wild life Protection act, high cost of eliminating the animal, lack of coordination with district

authorities, lengthy procedure for declaration as vermin, poor or no coordination between wild life biologists and plant protection specialists, lack of coordination in Department of Agriculture, Forests & Environment and R&D Institutions. He mooted that a National Plan is to be evolved to control monkey menace in India that should involve mitigation and adaptation, changing cropping pattern to evade monkeys and use of sprinkler irrigation to evade monkeys.

Dr. Anindya Sinha from NIAS, Bengaluru delivered a talk on monkey sterilization in Himachal Pradesh. Physiology, ecology and behavioural strategies of the Rhesus monkey *Macacamulatta* was discussed. He informed that Himachal Pradesh was one of the potential conflict zones with monkeys and this is reflected on the density of Rhesus monkey in the state and the extent of losses it causes. Over 1,537 attacks have been reported on people due to rhesus monkey from 2004-2013. According to him the management practices included the surgical sterilisation and oral contraception. Effectiveness of the treatment and post-surgical management was discussed. He observed that the challenges for the programme are the stringent rules of animal welfare board of India, ambiguity in transportation and macaque translocation rules. In attempt to scale down the conflict, he suggested for planting of wild bananas in the backyard.

The compensation and insurance scheme to mitigate human wildlife conflict was presented by Mr. Charudut Mishra, NCF, Mysore. The compensation and insurance payments for losses due to predation was briefed. Rampant corruption was a challenge in execution of the program during the process of settlement of claims. Benefits of micro insurance and institutional roles were dealt about.

Dr. Ajay Mishra, APCCF, Government of Karnataka provided information on unique protected areas, national parks and wild life sanctuaries in Karnataka. The increasing human and cattle pressure on wildlife home range, degradation/loss of tree cover, heavy usage of infrastructure and unchecked growth of ecotourism are the main reason for increase in conflict. Death due to wild life attack was on rise and the Government of Karnataka provides ex-gratia to farmers attacked by animals. Government responded by short and long term measures and rehabilitation of families from tiger reserves. He said attempts were made to identify the ecologically important corridors in the state.

Dr Kuldeep Singh Tanwar, Bharat Gyan Vigyan Samithi, Himachal Pradesh spoke about the hardships faced by farmers in Himachal Pradesh due to wildlife conflict and their attempts to obtain legal redress for their troubles. He requested that need for research and extension requirements on issues related to human wild life conflict.

The panel discussion then opened out to include other participants of the workshop who shared their views on the need for a new roadmap to deal with human-wildlife conflict. During the panel discussion Dr. N.P. Singh Director, Indian Institute for Pulses Research, Kanpur informed that pigeon pea in North India was devastated by nilgai. Though control measures were suggested by National Food security Mission, the farmers were reluctant to practice it. Dr. A. Pattanayak, Director, VPKAS expressed his concern for losses to crops due to damage by wild animals like wild boars and monkeys. Dr. Sukumar, IISc expressed that the Indians hesitate to cull the animals due to cultural issues. Dr. R.S. Tripathi suggested that formulation of policy at apex level of governance should include ICAR. Dr. Mishra informed that under the wild life protection act (Section A and B) any animal could be declared “vermin” if only it becomes threat to property. Dr. Sukumar recollected the release of the book “Parampara” by Honourable Prime Minister Narendra Modiji at “Climate Change Summit” held at Paris, quoting this he told we should have “preservational strategy”. He stressed on the point that “capturing” can be done instead of “culling”. The last issue he focussed was on the “changing in cropping pattern”. Dr. Abraham Verghese flagged the issue of frugivorous bat which is a major menace in horticultural crops. Bats are a major problem in grapes two weeks prior to harvest of grapes, the present technique of netting for trapping based on acoustics being used in Karnataka and Andhra Pradesh are being done by civil contractors leading to employment generation. Dr. Mishra stressed that culling can be replaced by use of rubber bullets which was being used in Scandinavia against bears and this can bring about fear in animals.

In his valedictory address Prof. Sukumar, IISc informed that in 1980's 150 people were killed by elephants and now the number is raised to 500 people per year. There are two dimensions to ecological basis of conflicts, one is proximate causation and other is ultimate causation. He suggested that we need to raise crops that are not palatable to animals.

A similar message about the need to foster co-existence was echoed by Dr. S. Ayyappan, DG (ICAR) and Secretary (DARE) and Baldev Raj, Director, NIAS, Bengaluru in their closing remarks to the workshop. After summarising the main insights provided by the discussion amongst the workshop participants, they stressed the need for synergistic activities among all the stakeholders a multi-pronged approach that is necessary to bring relief to farmers and conserve wildlife.

The following points emerged as the main recommendations of the workshop.

- Use of the term and concept of ‘coexistence’ should be encouraged over conflict. As we are heading into an age where interactions with wildlife is an inevitable part of our lives, we should work towards coexisting peacefully with wildlife rather than devising ways to deal with what we perceive to be conflict with wildlife.
- Formulation of policy at apex level of governance should include ICAR so as to address the issues related to farming.
- Research on wildlife conflict management in agro-pastoral ecosystem need to be funded adequately.
- ICAR and NIAS need to work together to develop innovative strategies that foster coexistence between wildlife and humans for productive agriculture.
- Periods of drought result in escalated levels of conflict as animals move towards human settlements beside forest ranges in search of better forage. Hence the cropping pattern in lands adjoining forest areas needs to be modified accordingly.
- Some European countries permit the use of non-lethal methods such as the use of rubber bullets to move the animals away from human settlement. It may be useful to use them in India too.
- The development of a database dealing with human-wildlife conflict issues in the country be initiated.
- The technologies developed for vertebrate pest management must be validated across AICRP VPM centres.
- A follow-up review meet of this workshop may be organized at the Veterinary College, Hebbal calling experts specializing in vertebrate pest management.



Dr. Abraham Verghese, Director ICAR - NBAIR welcoming Dr. S. Ayyappan, DG (ICAR) and Secretary (DARE). Dr. P.K. Agrawal, ADG (NASF) is looking on.



Participants of the workshop on Human wildlife conflict in agro-pastoral context





Dr. Baldev Raj, Director, NIAS addressing the participants



Dr. V.S. Ramamurthy, Former Secretary, Emeritus Professor, NIAS addressing the participants of workshop



Dr. S. Ayyappan, DG (ICAR) and Secretary (DARE) delivering keynote address





Participants of workshop on Human Animal Conflict in Agro-Pastoral context: Issues and Policies



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